Science
Within the
National Wildlife Refuge System

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for the
Conservation in Action Summit

Conservation in Action Summit

A new century of conservation challenges

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Table of Contents

Appendices

Executive Summary

Science in the National Wildlife Refuge System, a critical tool applied for specific management purposes, focuses on the use of best practices to understand complex natural systems and apply that information at the right time and place to make the correct management decisions to carry out the Refuge System mission. The systematic application of a good science program has an internal and an external impact. Internally, it strengthens the ability of the Refuge System to achieve its mission. Externally, a good science program enables the Refuge System to better contribute to national and international efforts to conserve fish, wildlife, and plants. The need for science-based management is underscored by the fact that each year about 3.75 million acres of the Refuge System receive some type of habitat management treatment to improve productivity for wildlife.

Ensuring effective conservation of the Refuge System's diverse resources for both "present and future generations of Americans," as called for in the Refuge System mission, is a complex and daunting task. The National Wildlife Refuge System Improvement Act of 1997 recognizes the complexities of natural resource management on refuges and calls for the integration of science in the management of the Refuge System.

This paper defines how a successful science program should function, the essential elements of a complete science program and the outcomes associated with each element. A condition assessment process is provided to measure success at the Refuge System's field stations.

Surveys of Fish and Wildlife Service employees, stakeholders, and friends, conducted in January 2004 by KRC Research, indicated that using good science in natural resource management is among the most important activities for the Refuge System. However, in terms of effectiveness, present science activities are only modestly effective, according to survey respondents.

The science team concluded that all five essential components of the Refuge System science program are in condition class 3, inadequate, or class 4, critical. Despite these low ratings, there are pockets of excellence in science in the Refuge System. In recent years, the Biological Needs Assessment (1998) and the ongoing *Fulfilling the Promise* effort have improved the Refuge System's science capabilities. Staying the course, expanding capabilities, and implementing these initiatives are now needed.

Working with partners has been and continues to be a vital aspect of science programs in the Refuge System. The complexity of the task, the fact that conservation benefits extend well beyond refuge boundaries, and the ever increasing stresses on natural resources make this an obvious time to renew, reinforce, and reinvigorate existing partnerships and to expand into new partnership arenas.

Introduction

The Refuge System conserves thousands of animal and plant species in habitats ranging from coral reefs in the Pacific to arctic tundra in Alaska to prairie wetlands in the upper Midwest to coastal habitats along the nation's shores to riverine/riparian, montane, grassland, and desert habitats in the interior. Ensuring

Science-based information is an enabler for prompt decision-making; it is a tool to be used in proper context and should not result in excessive delays in action.

effective conservation of these diverse resources is a complex and daunting task. A thorough understanding of complex natural systems is essential to guide the management and expansion of these lands.

Science has been described as an organized systematic enterprise that gathers knowledge about the world and condenses it into testable laws and principles. Within the Refuge System, science is applied for a specific purpose: the use of best practices to develop an understanding of complex natural systems and apply that information at the right time and place to make the correct management decisions to carry out the Refuge System mission. Science-based information is applied in an adaptive and iterative approach to continue learning and improvement over time. Science-based information is an enabler for prompt decision-making; it is a tool to be used in proper context and should not result in excessive delays in action. Actions are driven by conservation objectives, and many times decisions must be made using best available information. This ties back to the need to maintain an adaptive approach in use of science that allows for refinements over time.

The Refuge System is the leader among federal land management entities in undertaking continuing active intervention or management of lands and waters to enhance their value to fish, wildlife, and plant productivity or diversity. A host of management tools is employed, including revegetation, water level management, prescribed fire, farming, forest management, invasive species control, selective grazing, providing adequate water quantities, environmental quality management, public use management, facility management, law enforcement, and public outreach and involvement. Science provides the necessary underpinning that allows integration of these wide-ranging management activities into a comprehensive approach that best fulfills the Refuge System mission and purposes of individual refuges.

To best apply science in the Refuge System, it is essential that we work with a broad array of partners including state fish and wildlife agencies, universities, non-government conservation organizations, other federal agencies, tribes, volunteers, Friends organizations, and the general public. Effective partnerships and interactions among these entities are vital to the Refuge System's success. Regular and ongoing attention to these partnerships helps guide management actions on refuges, adds value by focusing on complementary goals and objectives, and ultimately provides the collaboration needed to assure effective conservation of fish, wildlife, and plants both nationally and internationally.

Purpose and Need for Science in the Refuge System

Science in the Refuge System is used to provide information to diagnose and prescribe appropriate management treatments and to develop and apply new knowledge to:

- Guide achievement of the Refuge System mission and purposes of individual refuges

Science provides the necessary underpinning that allows integration of these wide-ranging management activities into a comprehensive approach that best fulfills the Refuge System mission and purposes of individual refuges.

- Enable Refuge System activities to more effectively contribute to broader national and international conservation efforts
- Measure wildlife response to management in a way that identifies cause and effect relationships
- Ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained
- Guide future growth of the Refuge System
- Identify newly emerging problems/issues in a timely manner
- Guide selection of the most appropriate management techniques
- Gauge success of management activities and provide a feedback loop for improvements
- Understand, model, and predict how multiple forces affect natural systems managed or influenced by the Refuge System
- Guide administration of the six priority wildlife-dependent recreation activities
- Effectively gauge impacts of existing or potential uses of refuges

All of the above must be applied in an adaptive and iterative approach to further learning and improvement over time. Also, science in the Refuge System is not conducted only by refuge staff. We rely heavily on collaborative partnerships with outside entities to achieve our science goals.

Science is vital to achievement of the Refuge System mission because it:

- Gives a sound foundation for planning and goal setting
- Enables informed management decisions
- Increases reliability and predictability of management prescriptions
- Brings to light needed course corrections
- Adds credibility to contentious issues
- Improves priority setting
- Helps resolve resource conflicts

Increasing competition for natural resources is adding complexity to management

decisions, resulting in a growing need for reliable science-based information.

Improvement Act Direction

The National Wildlife Refuge System Improvement Act of 1997 recognizes the complexities of natural resource management on refuges and calls for the integration of science in the management of the Refuge System. The Act is replete with references to conservation roles that can only be accomplished through science, including Section 2 (3,4,6), Section 5 (3, 4), Section 5a (4)(A,B,C,F,N) and Section 7.

Interweaving social sciences with natural resource sciences is also evident throughout the Act. The application of science must not only include natural resource science but incorporate related fields of social, historical, and cultural resource sciences.

***Fulfilling the Promise* Vision**

In 1998, a national gathering of refuge managers and partners led to publication of *Fulfilling the Promise - The National Wildlife Refuge System - Visions for Wildlife, Habitat, People, and Leadership*, which provides a vision for the future based on principles anchored in the Improvement Act. The need to apply good science is woven throughout the vision statements and recommendations and is the underpinning for successful implementation of the Improvement Act.

The six *Fulfilling the Promise* vision statements most integral to a science program are:

- *Wildlife Comes First:* Refuges are places where wildlife comes first
- *Anchors for Ecosystem Conservation:* Refuges are anchors for biodiversity and ecosystem-level conservation and the Refuge System is a leader in wilderness preservation
- *Healthy Wildlife Habitats:* Lands and waters of the Refuge System are biologically healthy and secure from outside threats.
- *Leaders and Centers of Excellence:* The Refuge System is a national and international leader in habitat management and a center for excellence where the best science and technology is used for wildlife conservation
- *Models of Land Management:* The Refuge System is a model and demonstration area for habitat management which fosters broad participation in natural resource stewardship
- *A Legacy of Wildlife:* A strong and vibrant Refuge System provides an enduring legacy of healthy fish, wildlife, and plant resources for people to enjoy today and for generations to come

A Sidebar

Health Care Professionals for Conservation Lands

Many parallels exist between principles used by physicians managing human health concerns and conservation land managers caring for complex natural systems. As reasonable and prudent human beings, we maintain an awareness of our health. We are aware of how we feel and are alert to changes in vital signs such as changes in breathing rates, pulse, appetites, or energy levels, etc. In the same way, a conservation land manager is attuned to changes within the lands and waters under their charge by monitoring vital signs sufficiently to detect meaningful changes in condition.

Once a noticeable change or problem emerges, a whole new set of principles and practices take effect. They include: 1) first diagnose, then prescribe; 2) draw on expertise of specialists in complex situations; 3) develop and apply specialized techniques for situations outside the norm; 4) use adaptive learning to improve capabilities over time; and 5) make regular use of information and education tools.

A physician diagnoses a perceived health problem by measuring vital signs, assessing symptoms and their possible causes. Drawing from an extensive knowledge base, he or she then integrates all available information to prescribe a specific treatment (principle #1). In the same way, a conservation land manager must diagnose by gathering data, developing an understanding of symptoms, and then drawing on knowledge of conservation techniques before prescribing treatment for conservation lands.

Not all physicians are general practitioners. When complex health care concerns are encountered, specialists are called upon to help (principle #2); likewise, conservation land managers must access specialists such as hydrologists, botanists, ichthyologists, or fire ecologists to provide the needed expertise to deal with other than routine concerns. Physicians apply specialized tools and techniques in combination with careful monitoring and are constantly alert to the need to develop new tools and techniques where necessary (principle #3); conservation land managers likewise are in a constant learning and adapting mode to develop and apply specialized approaches to maximize effectiveness. Just as physicians use a timely and methodical approach to keeping records, conducting testing, and developing new tools, so too conservation land managers must have a long-term outlook that promotes adaptive learning and a focus on improving capabilities in the future (principle #4). Finally, both physicians and conservation land managers have much to gain by regular communications to raise awareness, share preventative techniques, and identify most effective solutions (principle #5).

Essential Elements of NWRS Science

Understanding the legislative direction in the Improvement Act, the recommendations in *Fulfilling the Promise*, and state-of-the-art scientific tools and techniques, the team identified the following essential components of a successful Refuge System science program:

1. Systematically collect, store, and make readily available data on status and trends of natural resources and related factors (includes monitoring of management activities)

2. Fill knowledge gaps by completing applied research or developing new tools to

respond to management concerns

3. Synthesize, analyze, and apply data to management needs

4. Provide adequate organizational capacity for sound science (sufficient staff with right mix of skills, training, tools, equipment, etc.)

5. Communicate results to both the scientific community and general public

Key Outcomes of Science

The outcomes of a successful science program correspond to the five essential elements in the preceding section:

1. Provide an awareness of the relative health of resources by the systematic collection of status and trends data; enhance such awareness and understanding by storing and making data readily available to internal users, outside partners, NWRS decision-makers, and others.

This outcome, the basic building block of a science program, provides a general yardstick for gauging whether fish, wildlife, and plant populations are increasing or decreasing over time, while it creates an ongoing awareness of basic vital signs. Baseline inventories and monitoring, including collection of monitoring data to assess the effects of management actions, are essential. A systematic approach to collecting information must use standard methods and protocols for biological and related data. Once collected, data must be systematically stored and made readily available to Refuge System staff as well as outside partners. In today's world of computerized data management this is being increasingly achieved through data entry and access using Internet hosted databases.

Adequate work in this area will facilitate planning and evaluation of management actions on individual refuges as well as collective effects at System, flyway, or broad ecological scales. Collaboration with partner organizations and synthesis with broader scale conservation actions are greatly enhanced through systematic collection and storage of data that can be accessed and used by a broad audience.

In establishing nationwide standards and protocols, a structured approach to collecting inventory and monitoring data must, nonetheless, be flexible to allow individual refuges to apply site specific protocols to meet unique logistics and needs. Whether applying a national or a local methodology, all data collection must be scientifically defensible, appropriate for analyses and integration with related data, and stored in a manner that can be broadly shared with others.

2. When available information does not adequately support natural or related cultural resource management actions, knowledge gaps are filled by conducting management-oriented research and/or developing new tools or techniques.

Familiarity with the complex array of natural resource issues must first be sufficient to identify emerging concerns and, secondly, must deal with new management problems either by 1) conducting studies or assessments specific to answering the concern; or, 2) developing new tools or techniques appropriate to the situation.

3. Decision making is strengthened at both the System-wide and individual refuge levels because data synthesis and analysis create a better understanding of how multiple factors affect natural systems managed or influenced by the Refuge System.

Management decisions are best supported by analysis that uses accepted scientific methods to interpret data; synthesis, which is the amalgamation of results from various analyses to provide an overall view of interrelated information; and application, which is the decision-making process utilizing conclusions to implement on-the-ground management activities. Synthesis of information is especially critical because it enables decision makers to understand, model, and predict how multiple forces impact natural systems. Data collected without synthesis is of very limited utility.

Synthesis and analysis are also important in detecting and responding to resource changes over time, which might otherwise be overlooked. Examples include gauging long-term impacts of invasive species, assessing or predicting impacts of climate change, modeling endangered species recovery options, and preventative strategies to preclude the need for endangered species listings.

4. Ensure that organizational capacity is sufficient to carry out a complete science-based management approach to: a) protect the biological integrity, diversity, and environmental health of the Refuge System; and b) meet the Refuge System mission and the purposes of individual refuges.

Organizational capacity is an ongoing process that enables the sustainability of a professional, relevant and legitimate organization. The term encompasses a mix of training, investment in property and equipment, information and communication strategies, personnel, processes, and internal and external relationships. For simplicity, the team focused on the availability of three key elements: a) appropriate expertise through adequate staffing in various scientific disciplines; b) ability to access latest tools and techniques through methods such as continuing education; and c) adequate equipment, technology and facilities to carry out a science program.

Complexities of natural resource management are growing, creating greater demand for a wider diversity of skill sets to meet difficult challenges. The changing dynamic of natural resource management practices is a major factor to understanding organizational capacity needs. For example, those managing a wetland impoundment on a refuge 20 years ago may have been able to rely on a relatively basic program that assured adequate quantities of quality water for waterfowl and a high degree of flexibility in how the impoundment was managed. Today, that wetland unit may well face more competition for water, which may be restricted in quantity, timing, and quality.

Twenty years ago, a manager could have adjusted water levels in the wetland impoundment at will – with minimal time spent doing so. Today, a manager may require assistance from a hydrologist to model and document water rights, a legal specialist to seek appropriate permits, a contaminant specialist to develop strategies for dealing with concerns about water quality. New water quality permitting issues may require that additional data be provided to a regulatory entity. Today, rather than managing with only waterfowl in mind, a manager works in a much more complex situation that takes into account the needs of a variety of fish, wildlife, and plants impacted by a management action.

Cumulatively, these factors dramatically increase demands on a biologist to: a) devise the best management approach under less than ideal conditions of water quantity, quality, and timing; and b) evaluate and report on the impact of management actions on wildlife and their habitats.

Adequate staff with the proper mix of skills must be available to accomplish on-the-ground biological management activities as well as monitor, record, and analyze the results and share findings with the scientific community and the public. For the majority of refuges, this is beyond the capability of a single individual. A multidisciplinary team of specialists is needed.

Embracing technology has been recognized as a key ingredient in delivering results.

Embracing technology has been recognized as a key ingredient in delivering results. Whether it's satellites to monitor wildlife or the Internet to inform the public, new and developing technology must be applied to make the Refuge System more efficient, effective, and accessible. Technology like Geographic Information Systems will remain a tool – not an end – for better planning and better wildlife and habitat decisions. Today, there are insufficient resources to complete this effort.

Science related staff must be devoted solely to providing an integrated approach to science-based management, not be diverted to such non-science activities as actual habitat manipulation (i.e. driving the tractor to mow moist soil units), law enforcement, or general administration.

With regard to adequate facilities and equipment, one issue that should be examined is whether the Refuge System has adequate equipment and facilities to host visiting scientists from partner organizations. The availability of on-site lodging at a remote location can be a key factor to making a collaborative science project possible.

5. Expand communication of science-based management so that the NWRS is: a) seen as a model and demonstration area for effective natural resource conservation; and b) a recognized center for excellence, where the best science and technology are used for conservation programs.

The Refuge System must communicate regularly within two communities: a) the scientific community to share lessons learned, stay in touch with new tools and techniques, and to encourage attention to conservation concerns where cooperative efforts

can be mutually beneficial; and b) the public to inform stakeholders of ongoing activities, explain rationale for sometimes controversial decisions, and helping allay conservation concerns.

Communications within the scientific community must include making information readily available to partners as well as communications within the Fish and Wildlife Service. Adequate internal communication should occur either prior to or concurrently with communications with the outside scientific community. It may be appropriate to develop different communication strategies for internal and external audiences.

Defining Success

A successful science program involves many components interacting with one another in sometimes complex manners. To define a meaningful and easily understandable description of success, key measures for each essential element are in the table on the following page. These factors can be used by individual refuges and the Refuge System as a whole to determine how effectively science is contributing to the Refuge System mission. Clearly, the Refuge System is not working in isolation. Working with partners in all aspects of this strategy is vital and essential. Effective partnerships provide the needed synergy and collaboration to help achieve both the Refuge System mission and other conservation objectives.

The table that follows lists outcomes and success factors for an effective Refuge System science program. It is largely focused inwardly in an effort to focus on actionable recommendations that can be taken to improve science programs. Not listed in the table are broader higher order outcomes of a more effective science program. These can be summarized as: 1) improving the capability to make sound management decisions; and 2) enabling the Refuge System to contribute in a meaning ful way to national and international conservation objectives. Achieving the outcomes in the table also directly contributes to these higher order outcomes.

Table 1
Measures of Success

Essential Element	Outcome at Optimal Condition	Success Factors
Systematically collect and store status and trends data	There is an awareness of the relative health of resources made possible by systematic collection of status and trends data; and an expanded awareness and understanding is enhanced by systematically storing and making data readily available to internal users, outside partners, NWRS decision-makers, and others.	All refuge field units: a) use and document scientifically valid methods to collect data; b) use approved standardized protocols designed for System-wide data collection (not yet developed); and c) place data in a NWRS managed or sanctioned database suitable for use throughout the conservation community. (Strategy under development.)
Fill information gaps by conducting management –oriented research or developing new tools	When currently available information does not adequately support natural or cultural resource management actions, knowledge gaps are filled by conducting management-oriented research and/or developing new tools or techniques.	All refuge field units: a) complete management-oriented research projects to address unanswered questions; and/or b) develop new tools and techniques where needed to address gaps.
Synthesize and apply data to management decisions	Decision-making is strengthened at both the System-wide and individual refuge level because data synthesis and analysis provide a better understanding of how multiple factors affect natural systems managed or influenced by the Refuge System.	All refuge field units regularly utilize data that have undergone scientifically valid synthesis and analysis to make and support management decisions.
Provide adequate organizational capacity	Organizational capacity is sufficient to carry out a complete science-based management approach needed to protect the biological integrity, diversity and environmental health of the NWRS and to enable fulfillment of the System mission and purposes of individual refuges.	All refuge field units have adequate organizational capacity via availability of: a) the right human resources (sufficient staff, skills in appropriate disciplines, needed training resources); b) current methods and techniques; and c) adequate equipment and infrastructure (equipment, vehicles, technology, facilities).
Communicate with scientific community and the public	Communication of science-based management is such that the NWRS is: a) a model and demonstration area for effective natural resource conservation; and b) a recognized center for excellence where the best science and technology is used for conservation programs.	All refuge field units regularly: a) communicate through scientific or professional societies; b) conduct public outreach focusing on science-based management; and c) publish or contribute to scientific or technical bulletins, brochures, or other publications.

Assessing Current Conditions -- Where Are We Today?

The Refuge System has long been a leader in fish and wildlife conservation, especially in habitat restoration and management. While many people still look to the Refuge System for leadership in this area, its ability to implement science

is frequently quite limited. The Refuge System does have pockets of excellence. However, overall performance is uneven, typically determined by individual refuge expertise and proximity to expertise such as science centers or universities.

One of the Service's greatest deficiencies is the current inability to identify the health of Refuge System habitats and species, and the scientific information needed to manage refuges.

Significant progress has been made over the last several years in improving refuge biology. The Biological Needs Assessment (1998), for example, led to establishing regional refuge biologist positions, holding a national forum on refuge biology, creating a handbook for biological reviews, creating a goals and objectives handbook, and updating habitat management policy.

Fulfilling the Promise teams are making progress as follows: a) baseline biotic and abiotic data standards have been adopted (WH 8); b) standard protocols for habitat management are under development (WH 10); c) standard protocols for species monitoring are being adopted by specialists in various species groups and assembled for adoption within the Refuge System (WH 1,2,3); d) a standardized approach to data management is being developed (WH 9); e) a Land Management Research Demonstration Area program was started, and f) recommendations on use of GIS in the Refuge System are under development (WH 9). These are good starting points; they need to be concluded and made operational.

KRC Research, in its January 2004 surveys of Fish and Wildlife Service employees, stakeholders, and friends, found that respondents considered using good science in natural resource management as one of the Refuge System's most important activities. However, respondents indicated that present science activities are only modestly effective. Providing adequate resources and more effective partnerships were the two areas that respondents believe offer the best opportunities for improvement in science efforts.

Each team, as it prepared for the Conservation in Action Summit, developed criteria for five standard condition classes as shown below.

Condition Class 1 - Optimal	(Continue successful efforts)
Condition Class 2 - Adequate	(Meets the requirement)
Condition Class 3 - Inadequate	(Needs action)
Condition Class 4 - Critical	(Needs immediate action)
Condition Class 5 - Unknown	

In establishing the condition classes, the teams sought to provide clear and easy-to-understand descriptors and consistent separation among the condition classes. Condition criteria are not extremely precise but are intended to be reliable reflections of performance. They are sufficiently rigorous to support reasonable judgments about condition that lends itself to high level decision-making. Condition class information is a diagnostic indicator to take our efforts strategically in the correct direction. It also

furthers an adaptive management approach where future iterations of performance measures will become increasingly more focused as we gain experience with their use.

Draft condition assessment criteria for science are in Appendix I. These criteria focus on capabilities at the field station level. It should be understood that the actions identified will be carried out by a combination of refuge staff and outside partners. Also, there are some corporate or national responsibilities assumed in the application of these criteria. For example, the systematic collection of data at the field level assumes that there will be a national process for establishing standard surveys and protocols.

Condition classifications may have significant implications for planning and budgeting purposes; in that regard, condition classes carry the following implications for new action or additional financial resources:

- *Condition Class 1 – Optimal*: Represents an ideal condition where current successful approaches should continue but no new actions or funding are needed.

- *Condition Class 2 – Adequate*: Represents a good condition that meets overall needs even though there may be modest weaknesses in some areas. It indicates that within the 15-year horizon of this summit, current operations are acceptable and no new funds are needed.

- *Condition Class 3 – Inadequate*: Represents a less-than-desirable condition that clearly warrants a change in actions or increases in funding. Needed actions are not as urgent or imminent as those under Condition Class 4.

- *Condition Class 4 – Critical*: Represents an urgent need that warrants immediate action or increases in funding.

- *Condition Class 5 – Unknown*: Insufficient information is available to make a judgment. This implies that either the component is not particularly important or that modest action or financial resources should be applied to improve understanding of the condition of this component.

The team provides its preliminary assessment in the chart on the following page:.

Essential Science Element	Current Condition Class
Systematically collect, store, and make readily available status and trends data	Class 4 – Critical
Fill information gaps via management–oriented research or new tools	Class 3 – Inadequate
Synthesize and apply data to management decisions	Class 4 – Critical
Provide adequate organizational capacity	Class 3 – Inadequate
Communicate with scientific community and the public	Class 3 – Inadequate

Rationale for the preceding ratings follows:

1. Systematically collect, store, and make readily available status and trends data. (Condition Class 4 – Critical)

Many refuges are engaged in some type of biological inventory and monitoring activities. However, there is no systematic approach in place that would allow comparison with other refuges or overall conservation efforts by others. Monitoring associated with management practices is often inconsistent or lacking. There are no national standards or protocols for data collection or storage.

The Refuge System is neither systematically storing nor making information available to the widest possible audience. Refuge field units are largely functioning as independent entities with limited attention to operating as a "system" and/or serving as a barometer of conservation status and trends across the nation.

The Refuge System has recognized that standardized practices and common approaches to data collection and storage would provide powerful tools for planning and evaluating the effectiveness of management actions at various geographic scales. A systematic approach would facilitate management at both the refuge and the ecosystem scale – it promotes biodiversity at the System level.

In addition, use of validated methods to collect and store information assures that data collection is scientifically valid, cost effective, and more reliable for application. *Fulfilling the Promise* teams have made significant progress in developing policies and procedures to allow the Refuge System to be more systematic in its approach. While these efforts are good starting points, they need to be made operational.

2. Fill information gaps via management-oriented research or new tools. (Condition Class 3 – Inadequate)

While it is believed that the most urgent new problems are receiving adequate attention, the team senses that many new problems are receiving inadequate attention or are going unnoticed. The team estimated that less than half of the need is being met.

3. Synthesize and apply data to management decisions. (Condition Class 4 – Critical)

The lack of a systematic approach to data collection and validation in combination with the lack of available staff and technology have resulted in very limited attention paid to the analysis and synthesis of data. This us not universally true. At times, good analysis and synthesis of data do occur before decisions are made. However, more typically, staff is overwhelmed by demands from such wide ranging activities as biological programs, health and safety of visitors, habitat management, administration, visitor programs, intense competition for water resources, law enforcement, facility maintenance, fire management, equipment management, cultural resource management, public outreach, technical assistance, environmental compliance concerns, and more. These demands leave little time for analysis and synthesis of information.

4. Provide adequate organizational capacity. (Condition Class 3 – Inadequate)

More and greater environmental stressors, growing competition for natural resources, and expanding human populations are placing growing demands on conservation lands. In recent years, the Refuge System has been striving to improve its capabilities to manage using science. However, gains have been modest. The team senses that organizational capacity is still less than half that needed to implement a successful science program.

5. Communicate with the scientific community and the public. (Condition Class 3 - Inadequate)

Although a considerable amount of scientific communication is occurring, no systematic approach exists. Communication tends to vary greatly from station to station. Lessons learned are often unshared; the "wheel" is all too often being reinvented at numerous locations. At the same time, communication with the public about science-based management actions is frequently insufficiently, leaving many confused about the Refuge System's actions and unwilling or uninterested in embracing and assisting conservation efforts. The team senses that communication is well below half of that needed for a well-rounded program.

Measuring Progress -- How Do We Know if We Are Improving?

Measuring progress toward implementing a successful science program will be monitored through a condition assessment process. Standardized condition classes are proposed to provide a consistent method to assess individual field station's abilities to implement a successful science program. The draft criteria are listed in Appendix 1 for each of the five essential elements. For each essential element, assessment criteria are provided for five condition classes: Condition Class 1 – Optimal (continue successful efforts), Condition Class 2 – Adequate (meets the requirement),

Condition Class 3 – Inadequate (needs action), Condition Class 4 – Critical (needs immediate action), Condition Class 5 – Unknown. Conservation in Action Summit participants and reviewers of this document are encouraged to recommend refinement or modification of the performance criteria displayed in Appendix 1 so that the criteria best reflect the most meaningful measure of success.

Relationship to Nationwide Conservation Efforts

In advance of the Conservation in Action Summit, the Science Team has begun to identify priorities for improving the application of sound science within the Refuge System. These ideas are presented in draft form, in no particular order of priority, in Appendix II. Input from summit participants along with follow-up comments will be used to refine and prioritize this list in order to develop a shared sense of what is most important to focus on and how to proceed.

Where do We Start? Developing Shared Priorities

Systematic implementation of science within the Refuge System would add tremendously to overall nationwide efforts to conserve fish, wildlife, and plants. It would promote sharing of information on status and trends of resources, enable better priority setting, and prompt sharing of the best tools and techniques to be applied to cooperative conservation efforts. Complementary efforts with a host of partners would be greatly improved by a more systematic approach within the Refuge System.

Key partners include state fish and wildlife agencies as well as state agencies with responsibilities for water, forests, parks and other lands. Other partners include national non-government conservation organizations, the Biological Resources Division of U.S. Geological Survey, other federal land managers such as the National Park Service, Bureau of Land Management, and the U.S. Forest Service. Local government and private groups are also logical partners as are many universities and colleges, especially in such activities as the development of methods for analysis and synthesis of data. Additional systematic sharing of information among all of current and potential is needed to improve opportunities to effectively conserve fish, wildlife, and plants.

Appendix I
Performance Assessment Criteria
Science

Condition Class	Essential Elements				
	Systematically collect, store, and make readily available status and trends data	**Fill information gaps by conducting management-oriented research or developing new tools**	**Synthesize and apply data to management decisions**	**Provide adequate organizational capacity**	**Communicate with scientific community and the general public**
Condition Class 1 Optimal	90-100% of data collection to develop/ refine station management actions and for broader application follows systematic monitoring and data storage protocols and facilitates access and analysis both within and outside the FWS.	90-100% of the time, management-oriented research is conducted, and/or new tools and techniques are developed whenever existing information fails to adequately address management questions.	90-100% of management decisions supported by scientifically valid data synthesis and analysis. Input to centralized databases is used for the broadest range of applications to meet needs of the NWRS at multiple scales.	90-100% of resources for scientifically rigorous work, done by the right people, with the right training and tools, and appropriate equipment and facilities at their disposal. Capacity routinely assessed by surveys of staff, stakeholders & partners.	90-100% of appropriate staff active in scientific or professional societies, attend at least 2 meetings, deliver at least 1 research presentation each year. Public outreach at least 4 times/yr. via print, media, or science bulletin focusing on science-based management.
Condition Class 2 Adequate	70-89% of data collection to develop/refine station management actions and for broader application follows systematic monitoring and data storage protocols and facilitates access and analysis both within and outside the FWS.	70-89% of the time, management-oriented research is conducted, and/or new tools and techniques are developed whenever existing information fails to adequately address management questions.	70-89% of management decisions supported by scientifically valid data synthesis and analysis. Input to centralized databases is used for the broadest range of applications to meet needs of the NWRS at multiple scales.	70-89% of resources available for scientifically rigorous work, done by the right people, with the right training and tools, and appropriate equipment and facilities at their disposal. Capacity routinely assessed by surveys of staff, stakeholders & partners.	70-89% of appropriate staff active in scientific or professional societies, attend at least 2 meetings, deliver at least 1 research presentation each year. Public outreach at least 4 times/yr. via print, media, or science bulletin focusing on science-based management.
Condition Class 3 Inadequate	50-69% of data collection to develop/refine station management actions and for broader application follows systematic monitoring and data storage protocols and facilitates access and analysis both within and outside the FWS.	50-69% of the time, management-oriented research is conducted, and/or new tools and techniques are developed whenever existing information fails to adequately address management questions.	50-69% of management decisions supported by scientifically valid data synthesis and analysis. Input to centralized databases is used for the broadest range of applications to meet needs of the NWRS at multiple scales.	50-69% of resources available for scientifically rigorous work, done by the right people, with the right training and tools, and appropriate equipment and facilities at their disposal. Capacity routinely assessed by surveys of staff, stakeholders & partners.	50-69% of appropriate staff active in scientific or professional societies, attend at least 2 meetings, deliver at least 1 research presentation each year. Public outreach at least 4 times/yr. via print, media, or science bulletin focusing on science-based management.
Condition Class 4 Critical	Less than 50% of all data collection to develop/ refine station management actions and for broader application follows systematic monitoring and data storage protocols and facilitates access and analysis both within and outside the FWS.	Less than 50% of the time, management-oriented research is conducted, and/or new tools and techniques are developed whenever existing information fails to adequately address management questions.	Less than 50% of management decisions supported by scientifically valid data synthesis and analysis. Input to centralized databases is used for the broadest range of applications to meet needs of the NWRS at multiple scales.	Less than 50% of resources available for scientifically rigorous work, done by the right people, with the right training and tools, and appropriate equipment and facilities at their disposal. Capacity routinely assessed by surveys of staff, stakeholders & partners.	Less than 50% of appropriate staff active in scientific or professional societies, attend at least 2 meetings, deliver at least 1 research presentation each year. Public outreach at least 4 times/yr. via print, media, or science bulletin focusing on science-based management.
Condition Class 5 Unknown	Insufficient information available to judge condition	Insufficient information available to judge condition	Insufficient information available to judge condition	Insufficient information available to judge condition	Insufficient information available to judge condition

Appendix II
Preliminary Recommendations to Improve the Contribution of Science to Fulfilling the Mission of the National Wildlife Refuge System

The following recommendations (not in priority order) have been developed by the Science Team to start discussions at the Conservation in Action Summit. Additional inputs in advance of the summit along with discussions at the summit and follow-up comments will be used to refine the list. The task at the summit is twofold: identify any additional actions/activities that need to be accomplished; and, prioritize the items. Many of these recommendations involve collaborative work by partner organizations. Please consider that these recommendations will continue to be pursued in a collaborative effort between refuge staffs and partners.

Outcome/Essential Element #1: There is an awareness of the relative health of resources made possible by systematic collection of status and trends data; and an expanded awareness and understanding is enhanced by systematically storing and making data readily available to internal users, outside partners, NWRS decision-makers, and others.

Recommended Actions/Activities:

- Establish a standardized approach for collection of priority biological data throughout the NWRS.
- Establish standardized protocols for collection of priority biological data throughout the NWRS.
- Establish a standardized NWRS-wide structure/approach to data storage and access that is FGDC compliant; allowing for consistent and secure storage of data collected through standardized protocols and making data efficiently available to a broad audience.
- Develop and implement a NWRS monitoring database that captures and shares information on biological responses to management activities on refuges.
- Acquire current vegetation maps (National Vegetation Classification System to the Alliance level) for all refuges in the system (see report by WH 8.1 Promises Team) to support planning and management decisions.

Outcome/Essential Element #2: When currently available information does not adequately support natural or cultural resource management actions, knowledge gaps are filled by conducting management-oriented research and/or developing new tools or techniques.

Recommended Actions/Activities:

- Establish an Internet database that identifies threats and conflicts to refuge resources and invites applied research and tools development by internal and external partners to help resolve or reduce conflicts.
- Develop a national level GIS capability to spatially analyze and display information about the NWRS.

- Increase partnering with U.S. Geological Survey to expand interregional management programs and studies.

Outcome/Essential Element #3: Decision making is strengthened at both the System-wide and individual refuge level because data synthesis and analysis provide a better understanding of how multiple factors affect natural systems managed or influenced by the Refuge System.

Recommended Actions/Activities:

- Develop integrated population and habitat goals and objectives at the System, regional, ecoregion, and individual refuge level for migratory birds and federally threatened and endangered species to guide strategic growth and long-term management of the Refuge System.

- All staffed refuge units have sufficient GIS database capabilities to address management needs (standard package consists of a GIS capable computer equipped with standardized software and at least one individual trained in its use)(anticipate about 50 percent of staffed field stations with a GIS person on staff) (at a minimum provide access to GIS expertise at the Regional level for all field stations).

- Establish a national level capability to serve as a central repository and source of information on tools and techniques to be applied in synthesis and analysis of biological data.

- Establish a national repository to electronically catalog, document, and store existing and historical information, reports, and data resources currently being housed in various forms at individual refuges.

- Establish guidelines for the storage and disposition of NWRS science information and records.

Outcome/Essential Element #4: Organizational capacity is sufficient to carry out a complete science-based management approach to protect the biological integrity, diversity and environmental health of the NWRS and enable fulfillment of the Refuge System mission and purposes of individual refuges.

Recommended Actions/Activities:

- Refuge field units are in condition class 2, adequate, for all of the key components of a successful science program.

- Develop conceptual models of major refuge ecological systems that may be used to guide adaptive management practices and monitoring activities.

- Provide sufficient scientific staff to adequately address resource management complexity; within five years provide a minimum of one PFT biologist per staffed field unit and within 10 years provide teams of three to five PFT biologists for the 50 most complex refuges. Positions must be devoted solely to providing an integrated approach to science based management and must not be diverted to non-science activities such as habitat manipulation, law enforcement, or general administration.

- Establish a “Citizen Science” program to provide a structured approach to engaging volunteers in gathering status and trends data and completing other science-based tasks.

- Establish a national level capability to facilitate identification, acquisition, distribution, and application of biotic and abiotic data layers throughout the NWRS (layers described in WH 8.1 report) and to identify and share useful data available from outside the FWS. Establish requirement that metadata be developed for all major data collections within two years.

Outcome/Essential Element #5: Expand communication of science-based management so NRWS is seen as a: model and demonstration area for effective natural resource conservation; and b) recognized center for excellence where the best science and technology is used for conservation programs.

Recommended Actions/Activities:

- Develop a Web presence to share information (both internally and externally) about NWRS science activities, including results of studies and investigations, best practices information on field tools and techniques, and best practices on data synthesis and analysis tools.

- Improve communication to Condition Class 2, adequate, for communications within the scientific community and the general public.

- There is no recommendation of action here: The core group of Land Management and Research Demonstration Areas are developing, testing, teaching, and demonstrating state-of-the-art management techniques for conserving fish, wildlife, and plants and exporting techniques that can be readily adopted by other refuges or other land managers.

- Improve functionality of Land Management and Research Demonstration Areas by providing facilities for temporary lodging for guest researchers.

- Increase attendance at regional and national conferences of natural resource professionals.

- Within five years, 25 percent of staffed refuges publish at least one peer-reviewed article per year for publication in professional journals.

- Document and highlight exemplary adaptive management practices.